

Experimental S- and X-Band Feed System Ellipsoid Reflector

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To support the Mariner 1973 X-band experiment, the S/X feed system has been designed and is currently under fabrication for installation on the DSS 14 64-m-diameter antenna. The system will allow both S- and X-band signals to be received along the same bore sight direction. Basic elements of the system are the ellipsoid reflector over the S-band horn and a dichroic reflector plate over the X-band cone. The first parts to be manufactured are the ellipsoid reflector and its backup structure. This article describes the ellipsoid reflector, the method used to form it, the measured accuracy of the finished part, and its connection to the backup structure.

I. Introduction

To receive S-band and X-band radio-frequency signals along the same bore sight direction on the 64-m-diameter antenna (Refs. 1, 2, and 3), two essential elements are required: a dichroic plate and an ellipsoid reflector. The dichroic plate is mounted at an angle over the X-band horn and reflects S-band signals while allowing the X-band signal to pass through the plate with no change in direction. The reflected S-band signal is then directed toward the ellipsoid reflector. This reflector is positioned over the S-band horn in such a way as to direct the signal down the axis of the horn. The system has been designed to allow both elements to be retracted so that individual horns can be used in a normal manner.

This article describes the fabrication of the ellipsoid reflector and its connection to the backup structure.

These are the first pieces of hardware to be manufactured. As additional pieces are fabricated, they will be described in future articles. Figures 1 thru 4 are photographs of the eggcrate surface template, the completed ellipsoid reflector, the backup structure resting on the reflector, and one of the flexures mounted to the backup structure.

II. Ellipsoid Reflector

The reflector is a segment of an ellipsoid whose semi-major axis is 2.3 m (90.928 in.) and the semi-minor axis is 1.88 m (73.993 in.). The edge of the reflector is described by the intersection of a cone with the ellipsoid. The surface is approximately 2.33 m (88 in.) long, 2.00 m (79 in.) wide, and 0.3 m (12 in.) deep and in plan is heart-shaped.

An investigation into the methods of forming such a dish surface was made during the initial stages of the project. Five methods were found that could be used and still meet the specified accuracy:

- (1) Drop hammer method.
- (2) Explosive forming.
- (3) Stretch forming.
- (4) Secret process (believed to be membrane forming).
- (5) Yoder hammer.

Methods (1), (2), and (3) require an expensive forming die. For method (4), being secret, the requirements were not known and the process is expensive. Using the yoder hammer, parts are relatively inexpensive to form, but accuracy is highly dependent on the operator's skill. The yoder hammer method was selected for three reasons:

- (1) A company was found that had the necessary operator skills.
- (2) It was the most economical method.
- (3) It had the shortest delivery time (important in meeting the schedule).

A surface template was required during the forming process to check progress, to use as a final checking template, and to hold the dish to the contour during the mounting of the flexures. First a female mold was made using a sweep template rotating on the axis of the ellipsoid. From this mold an eggcrate surface template was cast using wood intercostals and an epoxy surface (see Fig. 1). The accuracy of the template is within 0.25 mm (0.010 in.) of the theoretical surface. On the template is scribed the RF center (point I), the X and Y centerlines, and the reflector edge trim line.

Upon completion of the checking template, fabrication of the ellipsoid was commenced. The material selected was 1100-H14 aluminum. It was selected for its high electrical conductivity which causes less RF heating of the surface and thus less heat distortion. The material is 3.2

mm (0.125 in.) thick. The yoder hammer is a cam-operated power hammer operating at about 120 blows per minute. The forming anvil used was about 40 mm (1.5 in.) in diameter.

For ease of fabrication, two 1.22-m (48-in.)-wide sheets were used to form the two halves of the ellipsoid. They were welded together with 1100 filler metal after both halves were shaped as close as possible to the eggcrate surface. Little welding distortion was noted but some rework of the surface was necessary to bring the completed part into acceptable tolerance. Figure 2 shows the completed ellipsoid on its checking template.

Inspection of the completed part was made using back lighting and a feeler gage. The piece was resting on the surface template unrestrained. Measurements were made on 130 points of the surface. The specified surface tolerance was ± 1.5 mm (± 0.060 in.). The maximum point was 2.3 mm (0.09 in.) at two locations. Ninety-three percent of all points measured fell within 0.8 mm (± 0.030 in.) making the rms of the surface better than 0.6 mm (0.023 in.). The completed reflector unit mounted on the backup structure has a specified rms less than 1.5 mm (0.060 in.).

Figure 3 shows the backup structure resting on the ellipsoid. Currently in progress is the attachment of the backup structure to the dish. The connection is through nine flexures. Each flexure is 1.5 mm (0.06 in.) thick and has holes that keep the flexure stiffness constant even though the length of the flexures varies. (see Fig. 4 for photograph of one flexure). Bracket clips at short intervals attach the flexure to the ellipsoid reflector. This method of attachment will allow for thermal expansion of the dish and minimize thermal distortion.

III. Future Work

As fabrication continues on the ellipsoid assembly, future articles will describe the retraction mechanism and the space structure. Fabrication of the dichroic plate and support will start shortly. Future articles will describe the plate and its support structure.

References

1. Katow, M., "S- and X-Band RF Feed System," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VI, pp. 139-141. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1971.
2. Potter, P. D., "S- and X-Band RF Feed System," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VIII, pp. 53-60. Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1972.
3. Katow, M. S., and Hoggan, H. R., "Prototype S- and X-Band Feed System Hardware," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. IX, pp. 185-187. Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1972.

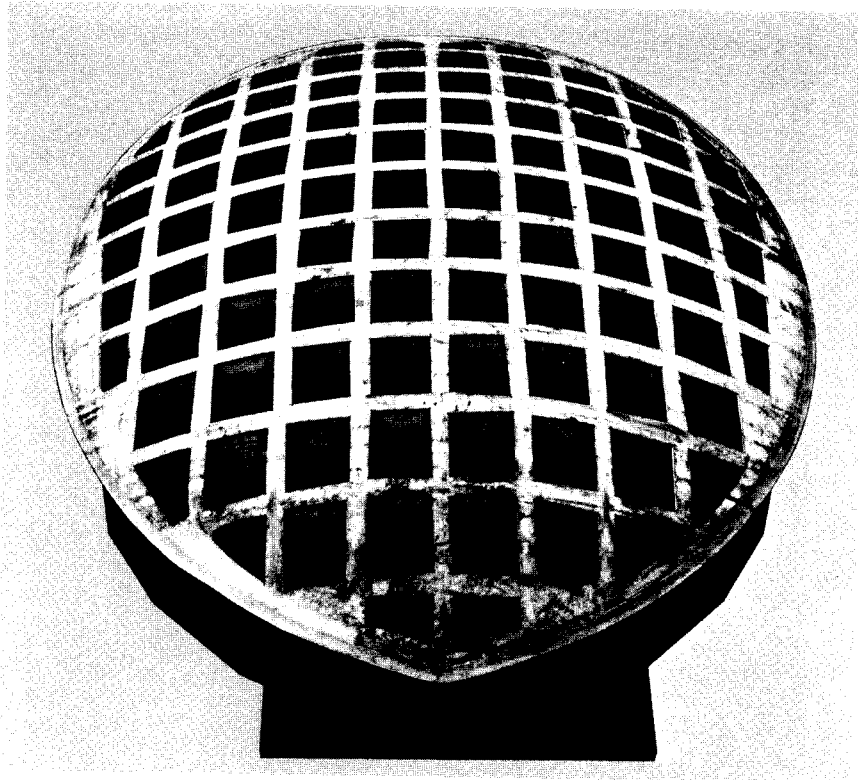


Fig. 1. Eggcrate surface template

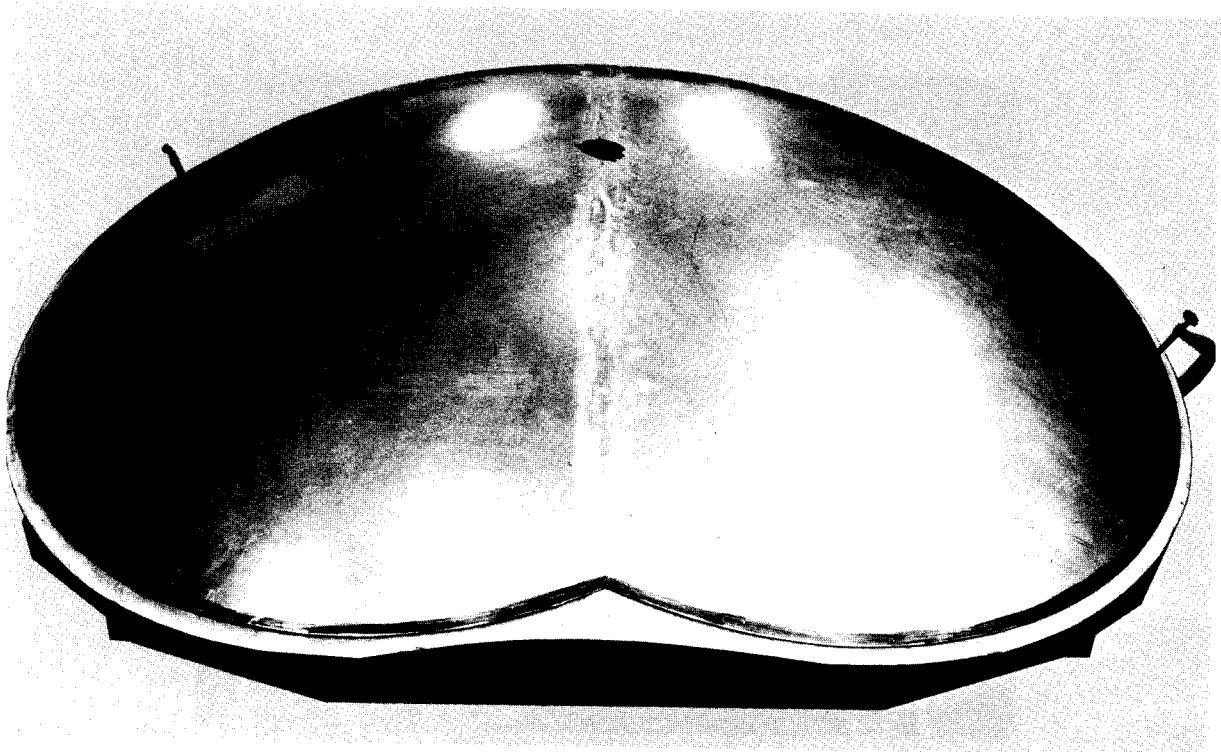


Fig. 2. Completed ellipsoid reflector

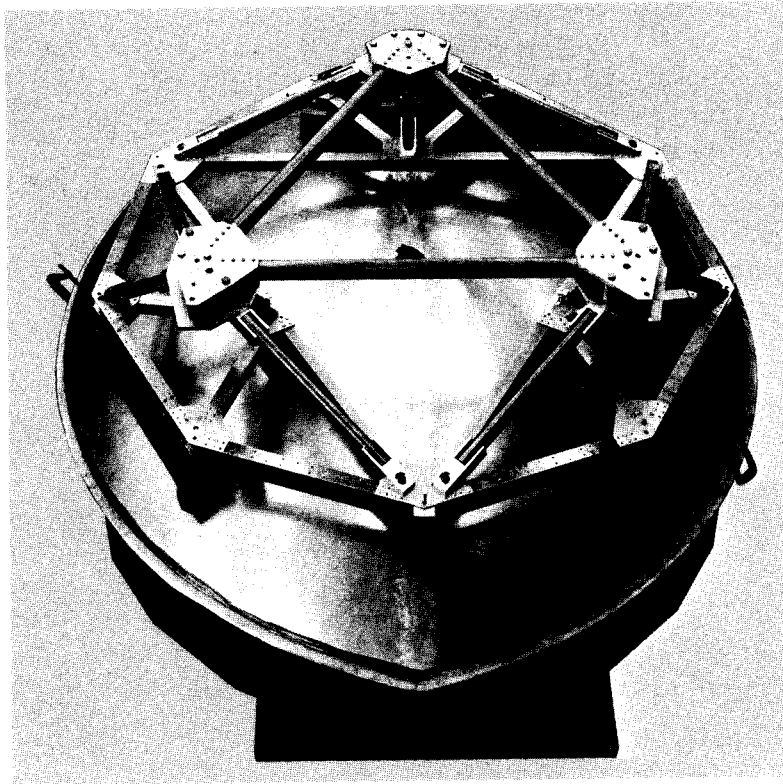


Fig. 3. Backup structure resting on ellipsoid reflector

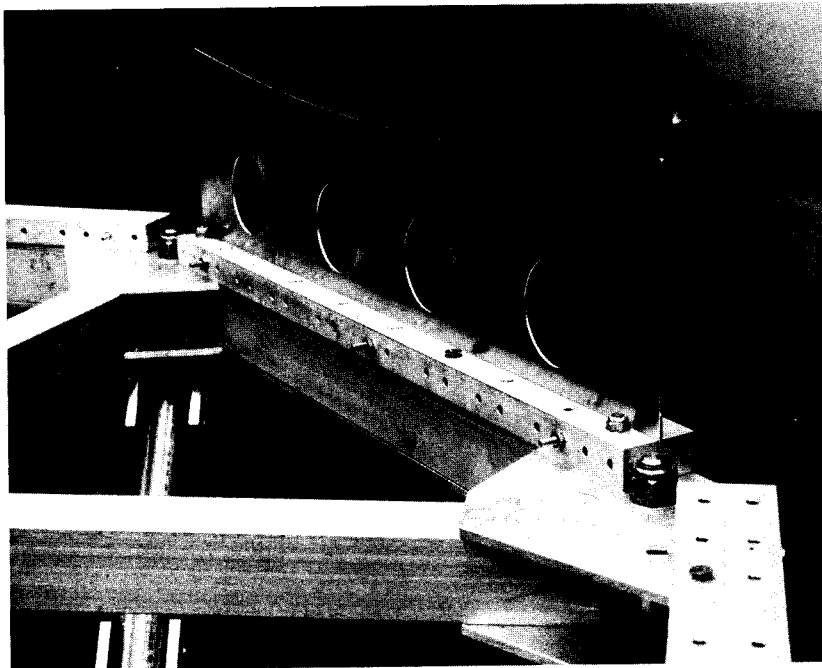


Fig. 4. Flexure mounted on backup structure